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XIV.

PRELIMINARY REPORT ON THE ECHINI OF THE
EXPLORING EXPEDITION OF H. M. S. "CHALLENGER," SIR C. WYVILLE THOMSON CHIEF OF
CIVILIAN STAFF.

BY ALEXANDER AGASSIZ.

[PUBLISHED BY PERMISSION OF THE LORDS OF THE ADMIRALTY.]

Presented May 14, 1879.

It was not my intention to publish a preliminary notice of the Echini collected by the *Challenger*. I hoped to be able to issue the descriptions of the species with my final report on the group. I am compelled, however, for the sake of retaining for the material of the *Challenger* expedition the priority of discovery, to notice briefly the magnificent collection of Sea-urchins intrusted to my care by Sir Wyville Thomson. The two expeditions of the U. S. Coast Survey steamer *Blake*, in which I was allowed, by the Superintendent of the Coast Survey, to carry on very extensive dredging operations in the Straits of Florida, the Gulf of Mexico, and the eastern part of the Caribbean Sea, have brought together extensive deep-sea collections, second only to those of the *Challenger*. In most of the groups, judging from my recollection of the *Challenger* collections when I had the privilege of examining them at Edinburgh, I should say that the collections made on the *Blake* not only include duplicates of the species of the *Challenger*, but numerous representatives of the principal families collected by that expedition. I wish, of course, as far as possible, to guard against any anticipation of the results to be drawn from the older collections of the *Challenger*. With the exception of certain Pourtalesia, of which I obtained only a few perfect specimens on the *Blake*, (although numerous fragments were constantly brought up by the trawl from depths of between 1,000 and 2,000 fathoms,) the Echini collected by the *Blake* represent some of the most interesting forms obtained by the *Challenger*, and often complement more or less imperfect *Challenger*

material. I shall, of course, not hesitate, in my final report on the *Challenger* Echini, to avail myself of this additional material. It is quite important, both from a systematic point of view and for determining more accurately the bathymetrical range of the greater number of the *Challenger* Echini, showing, as it does, that many species thus far considered as deep-sea species approach very nearly the hundred-fathom line.

Among the CIDADIDÆ, in addition to the new species of genera well known before, the most interesting form is a fine species of *Porocidaris*, n. sp. (*P. elegans*, A. Ag.). Large and valuable material was also collected for the study of *Goniocidaris camaliculata*, A. Ag., including its earliest stages and many varieties, as well as a most extensive series of *Goniocidaris tubaria*, showing a range in the variation of the spines unknown in any other species of the genus.

A new species of *Salenia* (*S. hastigera*, A. Ag.), the third now known, was also discovered. Of this many specimens were collected.

Among the ARBACIADÆ I note a species of *Porocidaris* (*P. prior-nigra*, A. Ag.), and a large series of *Cælopleurus Maillardi*. This has enabled me to make a careful study of this interesting genus.

In the family of DIADEMATIDÆ, a new genus allied to *Astropyga*, *Micropyga* (*M. tuberculatum*, A. Ag.), and two species of a genus closely allied to *Trichodiadema*, *Aspidodiadema* (*A. tonsum*, A. Ag., and *A. microtuberculatum*, A. Ag.), have been collected.

Among the ECHINOTHURIÆ a number of new species were dredged, both of *Asthenosoma* and of *Phormosoma*, in addition to the species already described by Sir Wyville Thomson in the "Echini of the Porcupine," the "Depths of the Sea," and the "Voyage of the Challenger." They are *A. pellucida*, A. Ag., *A. Grubei*, A. Ag., *A. tessellata*, A. Ag., *A. coriacea*, A. Ag., *P. luculenta*, A. Ag., and *P. tenuis*, A. Ag. Several small specimens of these genera were also collected, but it will be impossible to do more than refer them temporarily to existing species, as the material is hardly sufficient for exact determination. I hope, however, by making use of the many young Echinothuriæ collected by the *Blake* for comparison, to determine them more satisfactorily.

Among the ECHINOMETRADÆ nothing of importance was collected.

Among the TEMNOPLEURIDÆ excellent series of the species of *Salmacis* and of *Temnopleurus* were obtained; a new species of *Trigonocidaris* (*T. monolini*, A. Ag.), a *Cottaldia* (*C. Forbesiana*, A. Ag.), hitherto only known from the Chalk, and an exquisite genus, *Prionechinus* (*P. sagittiger*, A. Ag.), allied to *Salmacis* and *Podocidaris*.

The most interesting feature of the ECHINIDÆ proper was the occurrence of several northern forms, *E. acutus*, *E. elegans*, and *E. norvegicus*, in deep water in the tropics.

Not a single new species of Clypeastroid was found, and the number of specimens even was quite small. They do not play any important part in shaping the character of the fauna of deep water, and are, perhaps, the most strictly littoral group of Echini, indicative, at least in the present epoch, of comparatively shallow water, inside of the hundred-fathom line, and probably giving us a good guide as to the depth of the sea and the nature of the bottom of the cretaceous and tertiary shores, where they occur in such large numbers.

A recent species of *Catopygus* (*C. recens*, A. Ag.) is interesting as adding another of the cretaceous forms to those still found living.

By far the most interesting group of Echini collected by the *Challenger* is the group of POURTALESIDÆ. They were known before only from a couple of genera and a few species collected in the expeditions of the Coast Survey and by the *Porcupine*. The old material was very limited; the present material is, in some cases, abundant, and has enabled me to study the affinities of this remarkable group; passing on the one side from *Pourtalesia* proper to such groups as *Aerope*, W. Th., and *Aceste*, W. Th., with the gigantic suckers of their petaloid ambulacra, and on the other, through genera with short anal snouts, as *Cionobrissus*, A. Ag., and *Spatagocystis*, A. Ag., to *Echinocrepis*, A. Ag., and *Calymne*, W. Th., in which the resemblance to *Infulaster* gradually fades, and such genera as *Urechinus*, A. Ag., and *Genicopatagus*, A. Ag., appear, reminding us of *Holaster*, while *Cystechinus* recalls *Ananchytes* proper with many features of *Micraster*.

Of *Pourtalesia*, no less than six species are found in the collection, five of which were not among the earlier deep-sea POURTALESIDÆ. (They are *P. hispida*, A. Ag., *P. laguncula*, A. Ag., *P. rosea*, A. Ag., *P. ceratopyga*, A. Ag., and *P. carinata*, A. Ag.)

Of *Cionobrissus* (*C. revinctus*, A. Ag.), *Spatagocystis* (*S. Challengeri*, A. Ag.), *Echinocrepis* (*E. cuneata*, A. Ag.), *Genicopatagus* (*G. affinis*, A. Ag.), and *Urechinus* (*U. naresianus*, A. Ag.), only one species of each genus was brought home. An additional species of *Homolampas* (*H. fulva*) shows that the species of this genus grow to a very considerable size.

A number of specimens of *Paleopneustes* (*P. Murrayi*, A. Ag.) were collected near Kagosima, which it may be necessary to place in a separate sub-genus. There are peculiarities in the marginal fascioles and their development, the value of which can only be determined by

comparison with a more extensive series of younger stages. Fortunately there are quite a number of the young of *Paleopneustes* in the *Blake* collections.

In *Cystechinus* there are three species: *C. Wyvillii*, A. Ag., and *C. clypeatus*, A. Ag., the test of which is quite stout, while in *C. vesica*, A. Ag., the test is reduced to a mere film, so that even in alcohol the shape of this Sea-urchin reminds one of the crown of an old felt hat which has seen its best days.

The test of all the *POURTALESÆ* is quite delicate, the amount of limestone being, at the great depths where they occur, reduced to a minimum, and yet at the greatest depth at which these delicate Echini are found they are associated with Ophiurans which are by no means wanting in limestone.

Among the *EUSPATANGINA*, *Spatangus purpureus* occurs in the tropics at a depth of 400 fathoms, and *Echinocardium australe* is found littoral and at the great depth of 2,675 fathoms. With the exception of a new Spatangoid allied to *Maretia*, *Argopatus vitreus*, A. Ag., nothing demanding special notice was obtained.

Among the *BRISSINA* two species of *Hemiaster* allied to the cretaceous *H. prunella* were obtained (*H. gibbosus*, A. Ag., and *H. zonatus*, A. Ag.); also an extensive series of *Hemiaster cavernosus*, A. Ag., plainly showing that the several species thus far recognized, *H. antarctica*, *H. Philippii*, and *H. cordatus*, are only the different stages of growth of the males and females of Philippi's original *T. cavernosus*. In addition to *Periaster limicola*, A. Ag., which is inadvertently described from the Echini of the first *Blake* expedition, a new species of *Rhinobrissus* (*R. hemiasteroides*, A. Ag.) and two new species of *Schizaster* (*S. claudicans*, A. Ag., and *S. japonicus*, A. Ag.) close the list of this extraordinary collection.

I can give no better idea of the value of this collection than by stating that there are in the accompanying list not less than forty-four new species. At the time the "Revision of the Echini" was published, which included the large number of unknown forms collected by Mr. Pourtales in the Straits of Florida, there were not many more than two hundred species of Echini known, and since that time less than fifty species have been added to the list.

With regard to the geographical distribution of the deep-water species, the North Atlantic is in striking contrast with the North Pacific and the Southern Ocean. The Pacific is remarkable for its numerous species of littoral *Cidaridæ*, which are few in number in the Atlantic; of *Dorocidaris* and of *Porocidaris*, there is one Atlantic

and one Pacific species of each. *Goniocidaris* is a Pacific genus, with the exception of *Goniocidaris canaliculata*, which is the characteristic species of the great ocean belt uniting the extreme Southern Atlantic and the Southern Indian Ocean. *Salenia*, *Podocidaris*, *Cœlopleurus*, and *Aspidodiadema* each have one Atlantic and one Pacific species. The Northern Pacific, however, is characterized by the greater number of *Echinothuria*; the Atlantic collection of the *Challenger* containing only two species of the family, while there are no less than ten or eleven in the Pacific. *Trigonocidaris* has an Atlantic and a Pacific species. Several of the *Echini* proper, well known from the Northern European seas, extend far into the South Atlantic, as *E. acutus*, *E. elegans*, and *E. norvegicus*, the latter being even found in the Pacific, while the representatives of their species found along the southern extremity of South America, *E. magellanicus* and *E. margaritaceus*, extend far into the Southern Indian Ocean towards the Kerguelen and Heard Islands.

Of the Clypeastroids, *Echinocyamus pusillus* appears to be the only species having a wide geographical range and a great bathymetrical distribution; it extends from the Northern European seas to the South Atlantic.

The new species of *Catopygus* is a tropical Pacific species, as well as *Palæotropus*.

The species of *Pourtalesia* proper thus far known were, of course, Atlantic. The *Challenger* discovered two species in the Pacific; but by far the greater number of the species of this family were found in the Southern Indian Ocean in the track from the Cape of Good Hope to the Kerguelen Islands, and thence to Australia: three species of *Pourtalesia* proper (*P. hispida*, *P. phyle*, *P. carinata*), *Spatagocystis Challengeri*, *Echinocrepis cuneata*, *Genicopatagus affinis*, and *Urechinus nauresianus*, as well as the three species of *Cystechinus* (*C. vesica*, *C. clypeatus*, and *C. Wyvillii*). Of these one extends into the South Atlantic, *C. clypeatus*, the other into the South Pacific.

Aceste and *Aerope* are Pacific genera, and *Calymne* is an Atlantic genus. *Homolampas* and *Paleopneustes* each have an Atlantic and a Pacific species.

Of the *Spatangina* proper, nearly all are littoral Pacific species, with the exception of *Argopatagus vitreus* and the deep-water South Pacific *Echinocardium australe*. *E. flavescens* is also found reaching far into the Southern Indian Ocean. Of the northern species of *Spatangus*, *S. purpureus* extends well south in the North Atlantic and *S. Raschi* reaches as far as the Cape of Good Hope.

The most common species of the Brissina is *Hemiaster cavernosus*, which occurs in large number in moderately deep water at the Kerguelen Islands, the southern extremity of South America. *Hemiaster gibbosus* is a Pacific species, of which *H. zonatus* is the Atlantic representative. The northern *Brissopsis lyrifera* and *Schizaster fragilis* are found in the South Indian Ocean. The Pacific Schizasteridæ were *S. claudicans*, *S. ventricosus*, and *S. japonicus*, while *S. Philippii* ranged from the southern extremity of South America through the South Pacific to the Southern Indian Ocean.

The following are the main points of the bathymetrical distribution of the Echini of the *Challenger* expedition.

Among the Cidaridæ, *Cidaris* proper, *Phyllacanthus*, *Stephanocidaris*, and *Goniocidaris* are littoral, and extend but little beyond the 100-fathom line; though *G. canaliculata* has been found to 1,700 fathoms.

Dorocidaris extends to a depth of 600 fathoms, while *Porocidaris* was not found in less than 400 fathoms, and extended to a depth of nearly 2,000 fathoms.

The SALENIDÆ extend from the 100-fathom line to 1,850 fathoms.

In the ARBACIADÆ the species of *Arbacia* proper are littoral, and are found to a depth of 150 fathoms; from 80 to somewhat over 100 fathoms extends *Cælopleurus*, while the species of *Podocidaris* are the deep-water forms of this family, with a range of from 400 fathoms to nearly 1,100.

Among the DIADEMETIDÆ, *Diadema* and *Echinothrix* are strictly littoral, while *Astropyga* and the new genus *Micropyga*, closely allied to it, occur quite frequently from 75 fathoms to 250 fathoms, and even occasionally to a depth of 600. The genus *Aspidodiadema* commences at a depth of 100 fathoms, takes a greater development at about 600 to 700 fathoms, and has been found at a depth of over 2,200 fathoms. This genus, with the species of *Asthenosoma* and *Phormosoma*, are the deep-water types of the family, and of the ECHINOTHURIÆ, for although one of the species of *Asthenosoma* occurs in ten fathoms, the larger number of the species of the genus are not found in less than 100 fathoms, the greater number occurring in 200 to 300 fathoms and extending to 2,600 fathoms. The species of *Phormosoma* collected by the *Challenger* are found mainly in from 250 to 1,000 fathoms, being still common from 1,000 to 2,000 fathoms, and found as deep as 2,750 fathoms.

The ECHINOMETRADÆ are all shallow-water species, no species extending beyond the 100-fathom line.

Of the TEMNOPLEURIDÆ, *Prionechinus*, *Cottaldia*, and *Trigonocidaris* alone are deep-water species. *Cottaldia* occurring about 300 fathoms, *Trigonocidaris* from 500 to 1,000 fathoms, while *Prionechinus* ranges from 700 to nearly 1,100 fathoms. With the exception of *Temnopleurus Regnaudii*, A. Ag., which was found by the *Challenger* down to a depth of 275 fathoms, none of the other species of *Temnopleurus*, nor of those of *Microcyphus*, *Salmacis*, *Mespilia*, *Amblypneustes*, or *Holopneustes*, reached beyond the 100-fathom line, and by far the greater number of the species do not extend beyond the 40-fathom line.

Among the TRIPLECHINIDÆ, *Toxopneustes*, *Hipponoë*, and *Evechinus* are littoral.

In the genus *Echinus* proper, while a few of the species appear to be strictly littoral, we find several having a most extended bathymetrical range from strictly littoral to 1,600 fathoms, several northern species appearing in deep water in the tropics.

Among the CLYPEASTROIDS, with the exception of the FIBULARINA and of one species of *Peronella*, all the genera are littoral, *Echinanthus* alone extending to a depth of 120 fathoms, while no species of *Melilita*, *Encope*, *Echinodiscus*, *Astriclypeus*, *Laganum*, or *Clypeaster* was found beyond 70 fathoms.

The small number of Clypeastroids dredged by the "*Challenger*" is very striking, plainly showing that of this group the ECHINANTHIDÆ are eminently littoral, though in the FIBULARINA the species of *Echinocyamus* extend to 400 fathoms and those of *Fibularia* to 950 fathoms. One species of *Peronella* extended to 300 fathoms.

My own experience while dredging in the *Blake* corresponds with this. Although working in the region where the littoral species of the group are very numerous, we collected but few species of *Scutellidæ* or of *Echinanthidæ*, even while dredging near the 100-fathom line. The same is true of the former expeditions sent out by the Coast Survey.

Of the NUCLEOLIDÆ, the genera *Echinolampus* and *Catopygus* were limited to the region of 120 fathoms.

We now come to a strictly deep-water family, the POURTALESIDÆ, as we may for the present call the group to which *Pourtalesia*, *Palæotropus*, *Aerope*, *Aceste*, *Calymne*, and the like, belong. No species of the group has as yet been found in less than 375 fathoms; at this depth they occur rarely. They have been found more commonly at from 600 to 700 fathoms; they seem to take their greatest development at from 1,000 to 2,000 fathoms, and they are not uncommon

down to the depth of 2,300 to 2,900 fathoms; the genera *Palæotropus* and *Cionobrissus* being limited to a less depth than 1,000 fathoms, while *Aerope*, *Calymne*, and two or three species of *Pourtalesia*, are found within these limits, but also extend to the greatest depth at which any Echini have been found, viz. 2,900 fathoms.

The genera *Spatagocystis*, *Echinocrepis*, *Genicopatagus*, *Urechinus*, and *Cystechinus*, range mainly between 1,300 and 2,000 fathoms, one of the species of the latter genus extending to 2,225 fathoms, while *Aceste* has only been found in 2,600 fathoms thus far.

Paleopneustes occurs in the neighborhood of 300 to 400 fathoms, and *Homolampas* is found at a depth of 400 fathoms and over.

Among the SPATANGINA, the northern *Spatangus purpureus* is found in the tropics at a depth of 450 fathoms. *Eupatagus*, *Lovenia*, *Breynia*, and *Maretia planulata* are strictly littoral, not extending beyond a depth of 28 fathoms. *Maretia alta* has been found to extend to a depth of 800 fathoms; and the species of *Echinocardium*, like those of *Brissopsis*, although littoral, yet extend to great depth, one species, *Echinocardium flavescens*, to 150 fathoms, while *E. australe* has come up from no less than 2,675 fathoms. The only species of the genus *Argopatagus* was found at a depth of 800 fathoms.

Among the BRISSINA, *Rhinobrissus*, *Periaster*, *Metalia*, and some species of *Schizaster*, are either littoral or do not extend to the 100-fathom line, or but little beyond it. The species of *Schizaster*, however, reach a considerable depth; in one case 1,375 fathoms, in another 800, and in a third 345 fathoms. The species of *Hemiaster*, also, greatly vary in their bathymetrical range, the two species most closely allied to the cretaceous *Hemiaster prunella* extending from 340 to 800 fathoms, while *Hemiaster cavernosus* ranges from 15 to 400 fathoms. In *Brissopsis lyrifera* the bathymetrical range extends from 15 to 1,100 fathoms. The Mediterranean *Brissus unicolor* extends to a depth of 450 fathoms.

Dorocidaris bracteata, A. Ag., nov. sp.

This species is closely allied to *Dorocidaris papillata*. It is characterized by the small papillæ covering the abactinal area, the small size of the mammary boss of the primary tubercles, and the greater distance between the primary tubercles compared with the Atlantic species, *D. papillata*. The primary radioles are fluted, with a more or less serrated edge. The ambulacral system is also relatively much

narrower in this species than in the Atlantic species. — Amboyna, 100 fathoms, 15 fathoms.*

Porocidaris elegans, A. Ag., nov. sp.

The principal differences between this species and *P. purpurata* consist in the shape of the primary radioles. These are more uniform in shape, some of them three times in length the diameter of the test, with a comparatively short collar above the milled ring; the length of this collar is often half the length of the spine in *P. purpurata*. The abactinal system of this species is remarkable for the great size of the genital openings, placed entirely within the genital plates, and not extending, as in *P. purpurata*, into the apical plates of the interambulacral area. — Station 214, 500 fathoms; Station 164, off New South Wales, 950 fathoms, 410 fathoms.

Goniocidaris florigera, A. Ag., nov. sp.

In no species of the genus is there so great a difference between the spines of different parts of the test, or of different individuals, varying from short cupuliform or even spines terminating with radiating spokes, to long cylindrical radioles thickly covered with spines irregularly arranged, or to gradually tapering spines with delicate serrations and spines quite regularly placed. The ornamentation of the test is limited to small, deep pits at the angles in the median line of the interambulacral plates, with a sharp bare line indicating the sutures also at the junction of coronal plates with the poriferous zone. The lower part of the ambulacral plates is covered by minute granules, leaving the upper part of the plate bare; median ambulacral space wider than poriferous zone, coronal plates high, mammary boss small, scrobicular area deep, not confluent, completely separated by intervening secondary tubercles. Ocular plates heart-shaped, genital plates hexagonal, both covered by coarse granulation; papillæ sharp and slender; ten large anal plates, with smaller ones in centre; genital opening large, placed towards the centre of the plate. — Ki Islands, 129 fathoms; Station 204, 100 fathoms.

Salenia hastigera, A. Ag., nov. sp.

Differs from *Salenia varispina* by the closer and uniform granulation covering the abactinal system and the relatively smaller anal

* Only the principal localities are given, showing the bathymetrical and geographical range.

system. The spines are much longer also, nearly four times the diameter of test, varying but little in shape; they taper gradually and are covered from tip to base with numerous small spines closely packed in regular rings round the shaft. The number of primary plates is smaller both in the ambulacral and interambulacral areas, the three largest tubercles of the interambulacral area occupying in this species the same relative space of the test occupied by five in *Salenia varispina*. The large ambulacral tubercles of the actinal region so characteristic of the latter species are not found in *S. hastigera*, the actinal tubercles are but slightly larger than the other ambulacral tubercles. — Station 195, 1,425 fathoms; Station 170, 630 fathoms; Station 335, 1,425 fathoms; off Cebu, 100 fathoms.

Podocidaris prionigera, A. Ag.

This species is readily distinguished from its West Indian congener by the greater length of the spines; they are more regularly tapering, flattened, with very prominent serrations of the two edges. — Station 218, 1,070 fathoms; Station 205, 1,050 fathoms.

Aspidodiadema, A. Ag., nov. gen.

This genus is intermediate between the Cidaridæ proper and the Diadematiidæ. It has, like the latter, a thin test with the spines characteristic of that family. It has, like *Centrostephanus*, buccal plates. But the primary tubercles are few in number, as in the Cidaridæ, occupying with the scrobicular area and accompanying secondary spines nearly the whole of the interambulacral plate. The most characteristic feature of the genus is the ambulacral system. The plates, of a nearly uniform size, are small, forming, as in Cidaridæ, a narrow ambulacral system. The abactinal system consists of a narrow ring of ocular and genital plates placed side by side surrounding a large anal system. Two species were collected by the *Challenger*.

Aspidodiadema tonsum, A. Ag., nov. sp., in which the anal system is protected by five large plates, occupying the greater part of the space enclosed by the genital and ocular ring, and in which the actinal ambulacral tubercles form a double row of tubercles much larger than those of the abactinal region of the ambulacral space, which extends nearly to the middle of the test. — Station 170, Kermadec Islands, 630 fathoms; off Cebu, 100 fathoms; Station 122, 356 fathoms; off Macio, 1,700 fathoms.

The second species is *Aspidodiadema microtuberculatum*, A. Ag., nov. sp. It can be at once distinguished from its congener by the

larger number of plates protecting the anal and actinal systems, and also by the uniform size of the tubercles of the median ambulacral space along its whole length. The primary spines of this species are stouter and comparatively shorter than those of *A. tonsum*, some of which are nearly three times the length of the test; the number of primary plates is less in this species than in the preceding one. — Station 298, 2,225 fathoms; Station 134, 2,025 fathoms.

Micropyga, A. Ag., nov. gen.

Allied to *Astropyga*, it has, like it, a flat test, short spines, but a more compact abactinal system, a small actinostome with deep indentations for the passage of the gills, and primary tuberculation extending both in ambulacral and interambulacral areas to the abactinal system.

Micropyga tuberculata, A. Ag., nov. sp.

The spines of the abactinal surface are pointed, while on the actinal surface, where the primary tubercles form a closely-packed pavement both in the ambulacral and interambulacral areas, the primary spines are club-shaped, and the secondary spines alone are pointed. — Off Cebu, 100 fathoms.

Asthenosoma pellucida, A. Ag., nov. sp.

This species, judging from alcoholic specimens, was probably of light green or yellowish color; it is readily distinguished from *A. hystrix*, its nearest allied species, by the narrow ambulacral zone and the very regular arrangement of the secondary tubercles in a horizontal row occupying the centre of each primary plate. — Off Cebu, 100 fathoms; Station 192, 129 fathoms.

Asthenosoma Grubei, A. Ag., nov. sp.

This species is closely allied to *Asthenosema varium* of Grube, and these two species may perhaps properly form a separate section of the genus, while such species as *A. pellucida*, *A. hystrix*, and *A. fenestrata* would form a second subgenus. The material collected by the *Challenger* is scarcely sufficient to determine this. From the large number of specimens of the genus collected by the *Blake*, I hope to be able to determine, before the final report is published, the range of variation in one or two of the species. The test of this species is quite tough, the primary plates extremely narrow in both areas, well covered by primary tubercles arranged in one row; these are larger on the actinal surface and separated by few smaller secondary tubercles

rather irregularly placed. On the actinal membrane the tubercles of both areas are identical in size, forming regular concentric rings broken by the bare spaces in the median areas round the actinostome. The spines of the actinal surface are more or less trumpet-shaped at the extremity, with well-worn tips; those of the abactinal region are pointed and generally covered by a loose muscular sheath extending beyond the end of the spine, forming a series of swellings, from four to six, around the sharp cylindrical spine which it encloses. — Zamboanga, 10 fathoms.

Asthenosoma coriacea, A. Ag., nov. sp.

Distinguished from the preceding by its broader primary plates and by having similar spines on both the actinal and abactinal surfaces. The primary tubercles are few in number, limited mainly to the proximity of the edge of the test, both on the actinal and abactinal sides. One principal row extends to the abactinal area on the edge of the interambulacral plates of the abactinal side, and one on the actinal side. The remainder of the interambulacral plates are closely covered by small secondary tubercles or miliaries. In the ambulacral area the large primary tubercles extend only over a few plates on each side of the middle of the test. — Station 204, 100 fathoms; Station 173, 310 fathoms; Tongatabu; Station 299, 2,160 fathoms.

Asthenosoma tessellata, A. Ag., nov. sp.

The specimen on which this species is established may prove to be only a younger stage of the preceding. It presents, however, such striking features in the extremely regular arrangement of its plates, both on the actinal and abactinal sides, and their uniform size both in the ambulacral and interambulacral areas, that for the present it may be convenient to distinguish this species from *A. coriacea* until we know something more of the changes this group of Echini undergo during growth.

The same remarks apply to a number of small *Asthenosomæ* and *Phormosomæ* which, unfortunately, coming from many different localities, I am unable, on account of the great differences they show from the fully-grown forms, to associate them at present with any of the species here described. — Station 200, 250 fathoms.

Phormosoma luculenta, A. Ag., nov. sp.

This species is readily distinguished from the others of the genus by the greater solidity of the test, its pinkish or violet color seen

from the abactinal side, and the few long, large, dark violet primary spines of this surface, with similarly colored short, fine secondary and miliary spines standing out in bold contrast to the light test, and by the large size of the anal system and of the genital openings on the actinal side. The primary tubercles of the actinal side carry large spines tipped with white cup-shaped appendages, performing for this group the same functions as a similar tip on the spines of the actinal side of the Arbaciadæ. The secondary and miliary spines similar to those of the abactinal side. One specimen in the collection differs from the majority of the others in having the test and spine of a uniform yellowish-pink color. Station 200, 255 fathoms; Station 205, 1,050 fathoms; Station 332, 245 fathoms.

Phormosoma tenuis, A. Ag., nov. sp.

Closely allied to *Phormosoma uranus*, W. Th., from which it differs mainly in having larger and more numerous primary tubercles, especially on the actinal side, while on the abactinal side the small number of miliaries occurring in this species give it a very different facies. The coronal plates are more numerous in *P. uranus* than in specimens of the same size of this species, and the abactinal system is also proportionally smaller in *P. tenuis*, and the anal system made up of larger plates. — Station 274, 2,750 fathoms; Station 237, 1,875 fathoms.

Prionechinus sagittiger, A. Ag., nov. gen. & sp.

The apical system of this genus is similar to that of Salmacidæ. Single row of plates of pores on each side of median ambulacral line. Actinal membrane covered by plates. Spines serrated, somewhat flattened, radically different from those of any other genus of Triplechinidæ. As is well known, the serrations of the spines of young Echini proper disappear with age, and it is only among the Cidaridæ, Salenidæ, and the like, that we find spines greatly differing in allied genera or species, the spines of the Echinidæ proper being remarkable for their uniformity. Unfortunately only indifferently preserved specimens of this interesting genus were collected, and they are probably not fully grown, as the large anal system is still covered by a few large plates, as in all young Echini. Genital plates of uniform size; ocular plates notched in apex, excluded from anal system. — Station 164, 950 fathoms; Station 218, 1,070 fathoms.

Cottaldia Forbesiana, A. Ag., nov. sp.

There is only a single specimen of this interesting species (probably not full grown). It is closely allied to the tertiary *Psammechinus monilis*; pores are arranged in simple vertical rows, much as in *Temnechinus*. The spines similar to those of Salmacidae; large abactinal system of *Temnopleurus*, without, however, any trace of the indentations and pits of the Salmacidae and Temnopleuridae. Actinostome sunken, actinal membrane covered with ten large plates, spine white or a yellowish orange, primary tubercles of the same size in both areas, forming a very marked vertical row in the ambulacral area; secondaries forming indistinct horizontal rows near the ambitus, genital opening small, sharply cut; genital plates crowded with secondaries, anal system covered by few plates. — Station 173, 315 fathoms.

Trigonocidaris monolini, A. Ag., nov. sp.

This species is readily distinguished from *T. albida* by the structure of its actinal membrane and the striking ornamentation of the genital ring, and the relatively smaller number of primary coronal plates and coarser pitted reticulation, both in the ambulacral and interambulacral areas. The ten buccal plates occupy nearly the whole of the distal edge of the actinal ring, while in *T. albida* they are small and the actinal membrane is crowded by imbricating plates. A prominent ridge extends round the edge of the ocular plates and across the adjoining genital plates, forming a pentagon with rounded angles round the anal system; two or three prominent secondary tubercles are placed in the middle of the genital plates. No similar ornamentation is found in *T. albida*. — Station 170, 520 fathoms.

Echinus horridus, A. Ag., nov. sp.

Fragments and imperfect specimens of a large conical Echinus were collected in the Straits of Magellan which cannot be referred to any of the species already known from that locality. It seems to be readily characterized by its narrow poriferous zone. One principal row of primary tubercles in the interambulacral space, with secondaries in irregular diverging lines from it; the spines are remarkable for their length, even comparatively much longer than in some specimens of *E. acutus*; abactinal system very compact; large genital plates, small ocular plates. Actinostome small, not as large as abactinal system; color of test reddish brown when dry, spines darker color. — Off Tom Bay; Station 308, 175 fathoms.

Catopygus recens, A. Ag., nov. sp.

Only denuded tests of this species were collected. Apex anterior and corresponding with apical system. Prominent rounded keel at extremity of anal groove, sloping towards the actinostome, three genital pores, abactinal system indistinct, odd anterior and anterior pair of ambulacra of equal length, longer than posterior ones; tubercles forming uniform granulation over the test, phyllodes and bourrelets well marked. Test gibbous in median odd posterior interambulacral space between apical system and anal opening, also in the centre of the plates of the lateral posterior interambulacra, the swelling of this portion of the test becoming more prominent on the actinal side; actinostome sunken, upper edge of anal opening flush with the test, the posterior edge at the bottom of the anal groove. Ambulacral plates of nearly uniform size along sides of the test, becoming gradually narrower towards actinostome. — Station 192, 129 fathoms.

Palæotropus Loveni, A. Ag., nov. sp.

Differs from the West Indian *P. Josephinæ* in being more elongate, in having its greatest breadth near the posterior extremity; apical system, on the contrary, nearer the anterior extremity. It has also a larger subanal fasciole; the anus is placed on the upper plane of the truncated posterior end; its greatest diameter is horizontal, the posterior part of the actinal plastron forms a rounded keel. — Station 210, 375 fathoms.

Pourtalesia hispida, A. Ag., nov. sp.

The species of *Pourtalesia* proper are readily separated into two groups from the character of the test, the one containing such rectangular forms, or more or less bottle-shaped forms, as two of the species of *Pourtalesia* previously known (*P. miranda*, *P. phiale*), with the additional species discovered by the *Challenger* (*P. laguncula*, *P. hispida*), and such forms as *P. ceratopyga* and *P. rosea*, which are more or less triangular in outline when seen from above, their broad anterior extremity sloping gradually towards the anal end, while the rectangular forms, such as *P. hispida*, *P. carinata*, *P. Jeffreysi*, are intermediate between the two groups, having something of the rounded test of the former group, and the flattened actinal side with the more solid test of the last. The present species, *P. hispida*, differs from its nearest ally, *P. Jeffreysi*, in having a shorter anal snout, a more flattened actinal surface, a smaller actinal plastron, and a smaller number

of larger primary tubercles arranged in horizontal rows across the primary plates. Its outline is more rectangular anteriorly, and more nearly vertically truncated. — Station 147, 1,600 fathoms; Station 156, 1,975 fathoms.

Pourtalesia laguncula, A. Ag., nov. sp.

This is very closely allied to *P. miranda*; it is, however, more bottle-shaped, comparatively broader at the anterior extremity, shorter, with a wide anal snout and a more vertically truncated anterior extremity; shorter actinal plastron, with broad fasciole round the anal snout. This fasciole I did not detect in *P. miranda*, and as the unique specimen is at present in the hands of Professor Lovén I am unable to give its position in that species. — Station 191, 800 fathoms; Station 168, 1,100 fathoms; Station 232, 344 fathoms; Station, 244, 2,900 fathoms.

Pourtalesia carinata, A. Ag., nov. sp.

This is a large species with a comparatively stout test, quite gibbous, apex posterior, with its greatest breadth near the posterior extremity; largest primary spines on median interambulacral line of abactinal side of test in the anterior and in the odd interambulacra; rest of test quite thickly covered with small secondary spines, increasing in size towards the ambitus; on the actinal side the plastron carries still larger primary spines closely packed on the ridge of the actinal keel. — Station 299, 2,160 fathoms; Station 157, 1,950 fathoms.

Pourtalesia ceratopyga, A. Ag., nov. sp.

Test seen from above, triangular, with rounded apex formed by anal snout and base with rounded corners and re-entering centre, as well as re-entering sides. Seen in profile, the outline is rectangular, with the anal snout projecting from the posterior extremity like a knob. The actinal side is nearly flat, the abactinal outline somewhat rounded posteriorly (apex posterior), while abactinal system is placed nearer the anterior extremity, which also rounds off gradually. Seen endwise, the outline is triangular, with rounded corners; actinal groove less pronounced than in the species of the *P. miranda* type. The test is thickly covered by tubercles of nearly uniform size, irregularly arranged, carrying short slender spines; they are larger and carry longer spines along the abactinal keel and on the sides of the actinal groove. The color of the test, which is quite solid, is deep violet. — Station 298, 2,225 fathoms.

Pourtalesia rosea, A. Ag., nov. sp.

Fragments only of this species were collected. It is, however, well characterized by the peculiar shape of the anal snout, which is laterally compressed, truncated posteriorly. From the few fragments of the test found they must belong to a large species closely allied to *P. ceratopyga*. — Station 272, 2,600 fathoms.

Cionobrissus revinctus, A. Ag., nov. gen. & sp.

This genus is interesting, pointing as it does to the affinity of the Pourtalesia and Brissina. It resembles Brissopsis somewhat, has like it a peripetalous fasciole and petaloid ambulacra, and also possesses a well-marked subanal fasciole surrounding what corresponds to a rudimentary anal snout, somewhat like the beak of Echinocardium. The large tubercles within the peripetalous fasciole recall Macro-pneustes, and the groove at the end of which is placed the actinos-tome, with the rounded actinal surface with its keeled actinal plastron, remind us somewhat of the Pourtalesia. The spines of the test are pretty uniform in size, with the exception of the larger ones within the peripetalous fascioles. — Station 191, 800 fathoms.

Echinocrepis cuneata, A. Ag., nov. gen. & sp.

This genus has, like Pourtalesia, a deeply-sunken actinal groove and simple ambulacral pores piercing the test. It has, like the species of the group to which *P. ceratopyga* belongs, a triangular outline when seen from above, with re-entering base and sides and somewhat angular rounded corners, but has no anal snout; anal system placed on the actinal side. Seen in profile, the apex is anterior, corresponding with the abactinal system. The test is uniformly covered with small tubercles carrying small slender spines, with the exception of a few larger tubercles near the abactinal area in the interambulacral spaces, along the actinal keel and the anterior interambulacral spaces of the actinal side, and round the anal system. Seen endwise, the outline is that of a truncated cone. The color of the test is violet brown. — Station 147, 1,600 fathoms.

Spatagocystis Challengeri, A. Ag., nov. gen. & sp.

The new genera Spatagocystis, Cystechinus, Urechinus, and Geni-copatagus are among the most interesting Echini ever discovered, on account of their decided affinities to the strange group of Pourtalesia,

as well as their similarity, in many respects, to such cretaceous forms as *Holaster*, *Cardiaster*, and *Ananchytes*.

The present genus has a thin test, an outline from above resembling *Holaster*, but when seen in profile a well-developed actinal anal snout shows its affinity to the *Pourtalesia*. Seen in profile, the outline is regularly arched until it reaches the posterior extremity, which is pointed, projecting above the anal snout. This genus has a short but deeply sunken actinal groove and a small anal pouch. The color of the test of this species is pinkish, sparsely covered on the abactinal side by slender sharp spines of a uniform length. On the actinal side the spines are larger. — Station 157, 1,950 fathoms; Station 147, 1,600 fathoms.

Urechinus naresianus, A. Ag., nov. gen. & sp.

Urechinus and *Cystechinus* have not the sunken actinal groove which characterizes the *Pourtalesia*. In these genera the actinostome is more or less central, and does not differ materially in its structure or position from that of the more normal *Spatangoids*. The structure of the ambulacra, however, is, as in *Pourtalesia* and the other deep-water forms allied to them, quite different from that of the *Spatangoids*, with which externally they present many points of resemblance. *Urechinus* in outline and general appearance resembles, at first glance, *Neolampas*, but in the structure of the test it is more closely allied to *Cystechinus*, having like it a nearly flat actinostome and large ambulacral plates. The anal system alone recalls *Neolampas* by its position in a shallow groove placed above the ambitus. The young specimens differ but little from the older stages, the interambulacral projection over the anal system alone is not quite so prominent, and the actinostome less sunken. The number of primary tubercles in younger stages is limited to one for each plate, only becoming more numerous in older specimens when the whole test is thickly covered with fine slender miliary and secondary spines. The spines are yellowish white, the test of a reddish brown color or pinkish color. The lower surface of the test closely tuberculated. — Station 147, 1,600 fathoms; Station 146, 1,375 fathoms; Station 158, 1,800 fathoms.

Cystechinus, A. Ag., nov. gen.

This genus has the general appearance of *Ananchytes*, with the simple ambulacral system of the *Pourtalesia*; actinostome much less labiate than in that group of *Spatangoids*. This genus and *Urechis*

nus, as well as Homolampas and Palæotropus, with the actinostome nearly in one plane, form a ready transition to the actinostome of the Nucleolidæ and Echinolampadæ by the additional development of the interambulacral tubercles in immediate proximity to the actinostome and their crowding together to form bourrelets more or less prominent, and thus pass into such types as Neolampas, which have the simple ambulacra of this group, with the actinostome of the Echinolampadæ proper.

Cystechinus Wyvillii, A. Ag., nov. sp.

The outline of test seen from above is nearly elliptical, slightly broader anteriorly across the actinostome. Seen endwise, the outline is conical, with rounded apex and sides gradually rounding to ambitus. Actinal surface flat, slightly sunken actinostome, anal system near posterior edge on actinal side. Seen in profile, the outline is also conical, with rounded apex placed slightly posteriorly (apex and apical system coincide). The test slopes, with slightly re-entering sides towards the anterior and posterior extremities, passing into ambitus with a rather abruptly rounded outline near edge of test. The whole test is covered with short, sharp spines, carried by the few large tubercles arranged on the primary plates. Ridges radiating from the centre of each plate give to the side of the test, when denuded, a peculiarly ornate appearance. The color of the test is violet, spines of same color, darker. Test quite thin and very variable in outline according to age. Young specimens are quite flat. — Station 146, 1,375 fathoms; Station 147, 1,600 fathoms; Station 158, 1,800 fathoms.

Cystechinus clypeatus, A. Ag., nov. sp.

Judging from the fragments of the test of this species, it must have grown to a very large size, probably five or six inches in diameter. It differs from the preceding species in having a much shorter test; the arrangement of the plates of the anal system is quite different in this and the preceding species. In *C. clypeatus*, although the specimens are larger, there are fewer plates covering the anal system than in *C. Wyvillii*; in this species the genital plates are also much larger in proportion. Judging from a fragment of the actinostome, the actinal surface was more closely covered with primary tubercles than in the preceding species. — Station 133, 1,900 fathoms; Station 205, 1,050 fathoms.

Cystechinus vesica, A. Ag., nov. sp.

This species is at once distinguished from its congeners by the flexible nature of the test. This is so thin that its mere weight out of alcohol is sufficient to change the shape of the test, which has, when seen in profile, much the appearance of an old felt hat. The outline of the flat actinal surface is regularly elliptical. The anal system is placed just beyond the edge of the ambitus; the whole actinal surface is more thickly covered by large primary tubercles than the abactinal part of the test, where they are more distant; the spines are short, slender, sharp; the color in alcohol is greenish brown. The most prominent character of this species is the large size of the plates of ambulacral area, resembling, in this respect, more Galerites than Anan-chytes. — Station 153, 1,675 fathoms; Station 298, 2,225 fathoms.

Homolampas fulva, A. Ag., nov. sp.

The species on which this genus was originally established was quite small; it is therefore difficult to compare the two. Outline, seen from above, is slightly heart-shaped, greatest width near anterior extremity across abactinal system; anterior ambulacrum broadly re-entering anal extremity deeply indented. A few large tubercles in interambulacral spaces carry long curved spines; rest of test on abactinal side carries short slender spines of uniform length, closely crowded together; on actinal side, posterior ambulacral areas bare; actinal plastron and lateral interambulacral spaces paved with large tubercles regularly arranged and carrying moderately long curved spines; subanal fasciole broad, pentagonal in outline. Seen in profile, test slopes regularly from apex, the short side anteriorly, the long side towards anal extremity, which is anteriorly truncated; color in alcohol, yellowish. — Station 271, 2,475 fathoms.

Argopatus vitreus, A. Ag., nov. gen. & sp.

This genus is allied to *Homolampas*. It has, like it, a subanal fasciole, but no lateral fasciole, a more labiate actinostome. The abactinal surface is covered by distant primary tubercles of uniform size both in ambulacral and interambulacral areas. They are more numerous, but smaller, on the actinal surface.

In this species the apex and apical system are posterior, the outline from above is elliptical, slightly re-entering anteriorly. The test is quite low; actinal surface flat, regularly arching from apex to anterior and posterior extremities. The plates of the ambulacral and inter-

ambulacral areas of the abactinal side are of very uniform size, those of the bivium being, however, somewhat larger than those of the trivium. Station 191, 800 fathoms.

Paleopneustes Murrayi, A. Ag., nov. sp.

A number of large reddish-brown specimens were collected, unfortunately all nearly of the same size, so that I am unable to determine if the presence of a more or less well defined lateral fasciole is a sufficient reason for separating this species from the typical *Paleopneustes*, in which this fasciole either does not exist, or only in a very rudimentary condition. This species is at once separated from the West Indian species by the lesser height of the test, the smaller actinal plastron, the far greater length of the petaloid ambulacra, the proportionally larger primary tubercles on the abactinal side of the test, and the shorter truncated plane of the posterior extremity in which the anal system is placed. — Station 232, 345 fathoms.

Genicopatagus affinis, A. Ag., nov. gen. & sp.

This genus has striking affinities with *Holaster*, *Toxaster*, and *Cardiaster*. The lateral ambulacra and the odd ambulacrum have an identical structure, as in *Toxaster*, the ambulacra are slightly sunken, the double pores giving the ambulacra above the ambitus a slight petaloid appearance, much as in *Paleopneustes*. Seen in profile, the test is hemispherical, with prominently labiate actinostome and a flat actinal surface. The primary tubercles occupy the central part of the plates on the abactinal side of the test. On the actinal side the primary tubercles are large and prominent in the interambulacral areas. The ambulacral plates carry but a few secondary tubercles. The anal system is placed half-way between the ambitus and the abactinal system. The color of the test varies from pinkish to yellowish green. — Station 157, 1,950 fathoms.

Hemiaster gibbosus, A. Ag., nov. sp.

Seen in profile, the anal extremity is nearly vertically truncated, the apex is close to the posterior edge, thence the test slopes gradually to the anterior extremity, somewhat beyond the apical system, this is also vertically truncated and rounded, the actinal line is quite flat. Seen from above, the outline is elliptical, widest at posterior extremity. Test covered with tubercles of uniform size and equally distributed over the plates, except in the lateral posterior interambulacra, where the plates are comparatively bare, as well as on the actinal surface,

where the tubercles are larger and on the actinal plastron and interambulacral spaces; peripetalous fasciole broad pentagonal in outline; anal system quite small; anal groove shallow. — Station 232, 345 fathoms; Station 191, 800 fathoms.

Hemiaster zonatus, A. Ag., nov. sp.

The specimens of *Hemiaster* collected by the *Challenger* in the vicinity of the locality from which Loven's *H. expergitus* was obtained cannot be referred to it at present, although the differences between them may be due merely to age. In this species the spines are uniformly distributed over the whole abactinal surface of the test, the anal groove is deeper than in the preceding species, and the peripetalous fasciole is also broader. This species is more globular in shape, and closely allied to the cretaceous *H. prunella*. — Station 126, 750 fathoms.

Rhinobrissus hemiasteroides, A. Ag., nov. sp.

This is a much smaller species than the one which I figured in the Revision of the Echini, and it is referred to the genus with some doubt, as this species presents characters which remind us strongly of *Metalia* (the peripetalous fasciole) and of *Brissopsis* (anal fasciole), and even of *Brissus* proper. It has, like *Rhinobrissus*, the odd ambulacrum flush with the test, as well as the remarkably broad actinal ambulacral areas round the actinostome, and the great length of the spines in the lateral posterior interambulacra on the actinal side. It has, however, the lateral petals much as in *Metalia* proper, as well as its subanal fasciole, without the large anal branch so prominent in *Rhinobrissus*. The apex corresponds, also, as in *Metalia*, with the abactinal system, and is nearer the anterior extremity, which is posterior in *Rhinobrissus*. The spines of the abactinal surface are short, of uniform size, whitish color in alcohol. — Tahiti Harbor, 20 fathoms.

Schizaster claudicans, A. Ag., nov. sp.

This pretty little *Schizaster* is readily distinguished from its congeners by its high posterior extremity, nearly vertical, the sharp narrow clean-cut lateral fasciole, and the deeply sunken ambulacral petals fringed by an indistinct peripetalous fasciole. It has a narrow actinal plastron; anal opening placed immediately under the abactinal edge of the posterior interambulacral keel. Abactinal surface covered by close uniform tuberculation above the ambitus; odd anterior ambulacral petal shorter than the anterior pair of petals. — Station 192, 129 fathoms.

Schizaster japonicus, A. Ag., nov. sp.

Differs from *S. ventricosus* in having the posterior ambulacra proportionally longer, and forming a more acute angle with the longitudinal axis. It has a very distinct lateral and subanal fasciole; keel of median posterior interambulacral space forming a high crest at that extremity of the test, while *S. ventricosus* is remarkable for its comparatively flattened and rounded posterior extremity; ambulacra also more deeply sunken, much as in *S. canaliferus* and *S. Philippii*. These characters are early developed, and can serve, even in quite small specimens, readily to distinguish the two species. — Off Yokohama, 8–50 fathoms.